Karnataka State Akkamahadevi Women University, Vijayapura.

Synopsis of the proposed research

Title:

"Exploring the Nutritional Composition and Antioxidant Potential of Musa Acuminata 'Red Dacca Banana' from Kalyana Karnataka of Kalburgi Region."

For the degree of

Doctor of Philosophy

In the Department of

FOOD PROCESSING AND NUTRITION

Submitted By:

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Introduction

Banana is one of the oldest plants known by the scientific name Musa Acuminata (Musa sp.); in the world market Banana (Musa sp) export is the highest and fifth most important crop. In the market, bananas are affordable fruit and they can be found year-round nearly everywhere in the world. Banana is cultivated in over 130 countries, In India ranks first in production and third in area among fruit crops. Maharashtra (3924.1 thousand tonnes) is 1st highest banana production state followed by Tamil Nadu (3543.8 thousand tonnes), the other major banana-producing states are Karnataka, Gujarat, Andhra Pradesh, and Assam.

Several types of bananas are classified according to their taste and the colour of their skin. In India, cultivars include Dwarf Cavendish, Robusta, Red banana, Monthan, Nendran, Nyali, Poovan, Safed Velchi, Karthali, Ardhapuri, Rasthali, Basrai, Karpurvalli, and Grand Naine, etc. grown in Andhra Pradesh, Assam, Bihar, Gujarat, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Tamil Nadu, and West Bengal.

In the project, The selected variety of bananas is Red Banana scientifically known as Musa acuminata 'Red Dacca' whose cultivars are Kerala, Maharashtra, Tamil Nadu, and Karnataka. Red Dacca Banana is a group of varieties of bananas with reddish–purple skin. All the parts of the red Dacca banana have medicinal applications and can supply an essential nutrient required for various body functions.

Banana pulp is rich in phenolic compounds such as carotenoids, flavonoids, and vitamins (B3, B6, B12, C, and E). Phenolic compounds and natural antioxidants in banana contributes to the storage stability and exerting health benefits as well as contributes to the astringency of green banana. Furthermore, banana is richest with iron and potassium, magnesium, and other nutrient contents. The flours moisture content is less than 14 % it can resist microbial growth and contribute to storage. They also recorded protein content of 5.88 ± 0.19, fat content 2.16 ± 0.14, carbohydrate content will be 74.28 ± 0.37. The ash content showed 3.25 ± 0.31, potassium 982 mg / 100 g dry matter. They also are rich sources of antioxidant potential phytochemicals (polyphenols, flavonoids, vitamin c) and lesser in quantity of antinutritional factors (phytate and oxalate). In banana, mineral and phytochemicals composition of ripened and unripened banana flours will be analyzed and the total soluble sugar in unripened banana range from 37.5 to 43.8 mg / 100 g of the samples.

In current times, the use of natural products such as Banana, it is cheap and affordable dietary source of energy, high amount of protein which may improve the nutritional status of weaned infant, for adult it is highly recommended because it satisfy the energy needs. This is a main requirement for growth, repair and maintenance of the human body as well as maintains fluids, protein acts as enzymes and hormones, banana reduce and eliminate malnutrition due to hunger, important in lowering the risk of chronic disease, therapy for disease prevention and food prevent non-communicable diseases etc.

Banana needs drying during processing for preserving a longer period. As banana flour is prepared by drying, this flour has a high storability and a long shelf life.

Commercially, bananas are classified as dessert types and culinary types. The dessert-type banana is mostly eaten raw or used for making desserts and confections. The culinary types have starchy fruits and are used in the mature unripe form as vegetables. Banana are consumed as fruits, it may also be processed to other forms like smoothies, banana pan cake, bread, nectar and baby food. The banana is also processed to make Banana Flour, Banana Puree, Banana Pastilyas, Banana Chips, Dried Banana Blossoms, Pastilyas De Saging, Banana Vinegar, Banana Wine, Banana Sauce, Banana Figs and Banana Catsup. The peel of the banana also makes Paste from Banana Peeling, Sauce from Banana Peeling and Vinegar from Banana Peeling. The flour of banana is used as a functional ingredient in various food products; currently banana flour is used in the food industry for making bread, cake, pasta, biscuits, cookies, and baby food.

Edible cutlery as they are edible and are a better replacement for existing plastics. It is found to be delicious, biodegradable, eco-friendly as well as healthy, to solve the problem backdrop. Edible cutlery has been developed with all-natural ingredients i.e. the basic ingredients like rice, sorghum and millets. Additional ingredients like water, finger millet, Jaggery, oil, salt, biodegradable fruit wastes, grape seed flour, Xantan gum, pineapple, pomegranate, jackfruit seed powder, flax seed powder, chia seeds, psyllium husk, tapioca flour, soy protein isolated and morning glory stem fiber. Apart from regular ingredients, flavors also used such as sugar, ginger-cinnamon, ginger-garlic, cumin, celery, black pepper, mint-ginger, and carrot-beetroot. These ingredients are added for flavour, taste, texture and hardness of the product.

Review of literature

1. Importance of *Musa Acuminata 'Red Dacca'* banana verity.

K. P. Sampath Kumar, et.al. (2012) in their study reported that Red bananas have a red peel and the flesh of the fruit is light pink in color. The best red bananas are those that have been allowed to fully ripen at room temperature. According to this study, red bananas have a low iron content of 0.00 0.00.

Amarasingle et al, (2021) in their study Red banana (Musa acuminata), red Dacca are a group of varieties of banana with reddish–purple skin. Banana is one of the oldest plants and all their parts have a medicinal application

Iniubong Abasiodiong Thomas, (2023) in their study reported that red banana can supply an essential nutrient required for various body functions and the peel is a good source of vitamins A, C, and calcium significantly higher ($p > 0.005$) than Peel Red Banana Flour(PRBF). According to this study, red bananas have a low iron content of 0.00 0.00. The banana peel is a good source of calcium, vitamin A, and vitamin C.

2. Proximate analysis of available banana verities

Ogunlade et al, (2019), and Rebello et al, (2014) both studies show that Banana peel is also rich in many high values health-promoting antioxidant phytochemicals, such as anthocyanins, delphinidin, cyanidin, and a rich source of total phenolic compounds which are responsible for the very high antioxidant activity.

Kookall, (2018) reported that The total soluble sugar in unripened bananas ranged from 37.5 to 43.8 mg/100 g of the samples, according to an analysis of the proximate composition, mineral content, and phytochemical composition of ripened and unripened banana flours.

Mosa et al, (2015) reported the chemical composition of fresh banana peels as protein 10.49 g /100 g, fat 5.32g /100 g, carbohydrate 54.01 g / 100 g, moisture 21.96 g / 100 g, ash 8.23 g / 100 g.

Liyanag, et al (2016) observed in Banana flowers' approximate crude fat, crude fiber, crude protein, ash, and dry matter carbohydrate contents were 6.54, 23.71, 18.30, 34.36, and 65.49%, respectively.

According to *Mahloko, Silunge, Mashau, and Kgatla (2019)* if the flour's moisture content is less than 14 % it can resist microbial growth and contribute to storage. They also recorded protein content of 5.88 ± 0.19, fat content of 2.16 ± 0.14, and carbohydrate content was 74.28 ± 0.37. Potassium concentration per 100 g dry matter was 982 mg, while the ash content was 3.25 0.31.

Amarasinghe et al, (2021) in their study reported that The moisture content was 8.84 0.43, which was within the permitted range (20.0%) needed to provide a stable shelf life. They are also strong sources of antioxidant-potential phytochemicals (polyphenols, flavonoids, and vitamin C), in addition to banana flour, and have lower concentrations of anti-nutritional components (phytate and oxalate).

Nimesha K. Amarasinghe. et.al, (2021) in their study reported that The phenolic chemicals carotenoids, flavonoids, and vitamins B3, B6, B12, C, and E are abundant in the banana pulp. Phenolic compounds and natural antioxidants in banana contributes to storage stability and exert health benefits as well as contributes to the astringency of green banana. Furthermore, banana is richest in iron and potassium, magnesium, and other nutrient contents.

According to *Siji.S (2016),* Red bananas showed the highest β carotene (8.53 µg/100g). Banana types ranged in ascorbic acid concentration from 1.52 to 5.35 mg/100g. Red bananas were found to have the greatest ascorbic acid concentration (5.35 mg). About total antioxidant activity, the variety Padatti exhibited the highest activity with an IC50 value of 41.2 µg/ ml in petroleum ether while the variety Rasakadali (48.4) and Donovan (48.4) showed maximum activity in methanol followed by the variety Red banana with an IC50 value of 44.4 µg/ ml in methanol. The results revealed that varieties Rasakadali and Red banana were the most consumer-acceptable varieties compared to other varieties. According to the results of the current study, bananas are a dietary source of many nutrients and chemical compounds that are good for your health, including ascorbic acid, beta-carotene, dopamine, tannins, saponins, alkaloids, and flavonoids that have strong antioxidant and/or free radical scavenging properties.

3. Health benefits of available banana verities

Bukola C. Adedayo.et.al,(2016) in their study reported that The low sugar, GI, amylose, and amylopectin contents of the three banana cultivars, as well as their α-amylase and α-glucosidase inhibitory activities, could be possible mechanisms and justification for their recommendation in the management of type-2 diabetes.

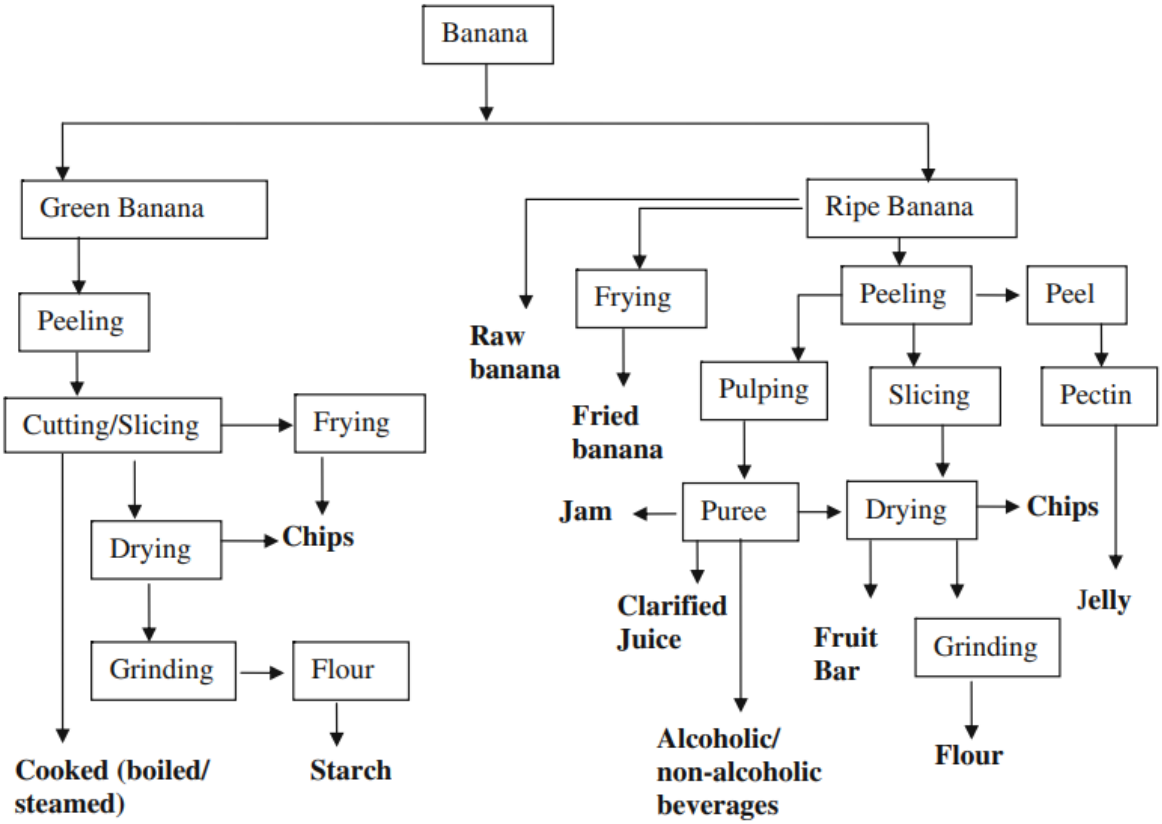
K. P. Sampath Kumar, et.al. (2012) in their study reported that Bananas are a good source of Vitamin C which helps to rebuild the immune system, they are also relatively easy to digest as compared to other foods and so they are invaluable to those with compromised immune systems. Vitamin C also increases the absorption of iron, increases the formation of blood, and reduces anemia or blood-related problems. Bananas can be a part of a high blood pressure diet because they contain potassium, which lowers and controls high blood pressure.

4. Study the shelf life of banana fruit.

Rameshwar Prasad et.al. (2015) studied This experiment was carried out in Randomized Block Design with three treatments and replicated four times. The observations were recorded based on Physical parameters i.e. Length of the fruits (cm), the width of fruits (cm), cumulative physiological loss in weight (CPLW) (%), and specific gravity (%) as well as Chemical Parameters i.e. total soluble solids (0Brix), acidity (%), ascorbic acid (mg) and sugars (%). The data recorded during the observation was used for analysis to test the level of significance as per the method given by Chandel, 1984. The significance between any two means was judged by calculating critical difference (C.D.) at a 5 % level of significance, according to the ANOVA Table

5. Process of banana

The general flowchart of processed and unprocessed products of banana are listed below.



Source: Mohapatra. D et al. (2011)

Process of drying banana powder

According to *V Raja. et.al, (2022),* from the findings of the study, it is brought to line light that three pre-harvest sprays with potassium sulfate 1% +manganese sulfate 0.5% + calcium chloride 0.5% + boric acid 0.1%) (T11) at immediately after traveling, one month after traveling and two months after traveling improved the yield, quality and postharvest life of banana cv. Red banana.

According to *Nimesha K. Amarasinghe. et.al, (2021*), Banana needs drying during processing for preserving a longer period. Banana flour has a high level of storage ability and a long shelf life because it is made by drying. Preparation of banana flour. After various adjustments, banana flour was made. The raw materials were carefully cleaned with potable water, then peeled, sliced (1.5-2 mm thick), and dried at 50° C for 48 hours. Using a 355-micron mesh,

the dry banana was crushed and screened. The flour was stored at room temperature until analysis in an airtight container.

6. Product development and sensory evaluation of incorporated banana powder

In the report of *Nimesha K. Amarasinghe. et.al, (2021)* reported that Currently, the food sector uses banana flour to make baby food, pasta, biscuits, cakes, and bread.

Product development of edible cutlery

According to the report of the *United Nations Development Programme,(2018)* Every year, India generates 15 Mt of plastic waste, of which only one-quarter is recycled.

According to *Hemraj. Narhar. Patil. (2018*) reported that cutlery can be consumed at the end of the meal. It may be used to eat any form of food, hot or cold, solid or liquid; one can have cold desserts and a hot soup at the same time.

N. Natarajan, M. (2019) reported in their study, This business was started by Peesapathy and makes edible cutlery (spoons, forks, and even chopsticks) out of rice, wheat, and dried millets (jowar or sorghum). Chopsticks and spoons can be used with food and water without being drenched. The spoons may be stored for a very long time—2 years—while remaining crisp. They use flavors like sugar, mint ginger, ginger-cinnamon, ginger-garlic, cumin, celery, black pepper, and carrot beet.

Bisma. Iqbal, (2021) Reported in their study, the edible cutlery is prepared with ingredients like Wheat flour, rice flour, sorghum flour, sugar, butter, salt, and vanilla essence are blended and baked in an aluminum tray at 180ºC for 40- 60mins. results conclude that blend product shows higher values for water holding capacity and has oil binding capacity. The edible cutlery is found to contain 2.68%, 1.75%, 1.82%, 4.7%, and 0.8% percent moisture, ash, crude fat, crude protein, and crude fiber respectively. The Acid Detergent Fiber (ADF) and Neural Detergent Fiber (NDF) were calculated as 1.7% and 3.7%. The percentage of starch was 4.82.

T Rahul Roy, et.al. (2022) in their study reported that cutlery is made up of plant-based products like rice, sorghum, wheat, soy, and rice bran flour. The nutrient composition was Proteins (1.06g), Fat (0.12g), Mineral (0.13g), Fiber (0.19g), Iron (0.56mg), Calcium

(2.43mg), Carotene(3.97mg), Thiamine (0.03mg), Riboflavin (0.01mg), Niacin(0.28mg) and Folic acid(1.33mg)

According to *Rashid, (2019)*Mixing, Kneading, Moulding, Baking, Cooling, and Packing were the process of making edible cutlery.

In the report of *Sood and Deepshikha, (2018)* the process of edible cutlery was explained that Sorghum flour (Sorghum bicolor) and rice flour are two of the most common (Oryza sativa) primary materials for manufacturing the cutlery. Then kneaded well to form a fine dough. Later the dough is spread to make a fine sheet and the process like molding takes place with a predesigned mold followed by cutting and baking of the product at a temperature of 166 °C for 10-15 minutes and then let it cools and packing it in an airtight package and store at a cool, dry place.

Cutlery is a rich source of minerals, vitamins, carbohydrates, protein, and fiber. *(Sood and Deepshikha, 2018).*

It is good in calories and nearly fat-free and diet-friendly. It consists of several nutritional content-like vitamins B1, B2, B3, and B9, vitamin E, and minerals like iron (Fe), and calcium (Ca) *(Munir, 2017).*

They are also a good source of energy with the nutritional supplement. they exhibit various health benefits such as anti-cancerous, anti-obese, anti-diabetic, and cardiovascular disease (*Morya et al., 2022).*

It has a shelf life of 2 years from the manufacturing date when it is stored in a dry and cool place *(Natarajan et al., 2019).*

Sensory evaluation

Sensory quality evaluation plays an important role in the acceptability study of any new product. Sensory evaluation is made "to reflect the common man's preference" to keep food quality at a specific standard and to investigate process changes, cost reduction, product enhancement, market development, and market analysis. *(Manay and Swamy, 2002)*. The overall acceptability of the banana will be assessed through organoleptic evaluation.

Organoleptic quality consists of judging the quality of foods using human sensory organs-eye, nose, and mouth.

The primary consideration for selecting and eating a food commodity subjectively is after assessing the sensory qualities of fruit for its appearance, color, flavor, taste, and texture *(Piggot, 1988).*

According to *Plemmons and Resurrection, (1998).* Trained judges will select for sensory evaluation, based on the following criteria, i.e. those who

- Had an affinity for banana consumption.
- Possessed the ability to identify basic tastes.
- Were able to detect smell and aroma/flavor.
- Were non-smokers and nonpan chewers.
- Could express their judgment

The organoleptic evaluation was conducted by a selected panel of judges using a scorecard.

The sensory attributes such as appearance, color, flavor, taste, and texture will assess by assigning scores as described by *Sudha et al. (2007).*

Objectives

The following objectives are carried out in this research.

1) Documentation of **Banana varieties** and their **medicinal properties** of selected bananas in the North Karnataka region especially with respect to the **Kalburgi district**
2) **Physico-chemical properties** and **Approximate analysis** of Red Dacca Banana.
3) To study the **Antioxidant properties** and **Phytochemical** of the Red Dacca Banana
4) To **Process and standardize** the Musa Acuminata Red Dacca Banana
5) To study the **storage and shelf life** of Musa Acuminata 'Red Dacca' banana powder and its products.
6) To study the **sensory evaluation and consumer acceptance** of developed products like edible cutleries

Methodology

1) **Documentation of Banana varieties and their medicinal properties of selected bananas in the North Karnataka region especially with respect to the Kalburgi district**

A. Development of a questionnaire

The questionnaire which included general information, locally available banana varieties, consumption of banana varieties, consumption pattern of banana varieties, seasonal availability of Red Dacca Banana, consumption pattern of Red Dacca Banana, commonly consumed recipes prepared using banana and Red Dacca Banana, difference between Red Dacca Banana and other Banana varieties, general knowledge regarding nutrition, health benefits and medicinal properties of Red Dacca Banana will be developed in consultation with nutrition experts, statisticians and literature

B. Pretesting of the questionnaire

The developed questionnaire will be pretested in nonsample areas to test its suitability and avoid ambiguity.

C. Collection of the primary data

The primary data will be collected from the local area of north Karnataka region, i.e. the people like farmers, local vendors, grocery clerks, and consumers of the different districts,

personal interview method will be adopted to elicit required information using a developed questionnaire, and the data obtained will be tabulated and analyzed.

2) Physio-chemical properties, and Drying process of selected Banana varieties.

2.1.Collection of Samples

The fresh and mature banana (Musa Acuminata) variety of bunches will be purchased from the local markets of the north Karnataka region. The Musa Acuminata 'Red Dacca' Banana will be collected from the Red Dacca Banana plant farmer of north Karnataka, Kalburgi region.

2.2. **Physio-chemical properties**

Table 2.1. Estimation of physical properties analysis, methods, characteristics, and Description.

<table>
<tr><td>Physical analysis</td><td>Methods</td></tr>
<tr><td>Size</td><td>By using scales estimate the length of RDB
<table>
<tr><th>Characteristic</th><th>Description</th></tr>
<tr><td>Length</td><td>The measurement from stem to tip</td></tr>
<tr><td>Diameter</td><td>The measurement across the widest part</td></tr>
<tr><td>Circumference</td><td>The measurement around the widest part</td></tr>
<tr><td>Weight</td><td>The weight of the banana</td></tr>
<tr><td>Size Category</td><td>Small, medium, large, or extra-large</td></tr>
<tr><td>Uniformity</td><td>Consistency in size among a batch of bananas</td></tr>
<tr><td>Comparison</td><td>Comparing the size to a reference (e.g., standard sizing)</td></tr>
</table>
By assessing these characteristics, you can determine the size of bananas and categorize them accordingly</td></tr>
<tr><td>Shape</td><td>Estimating the shape of RDB
<table>
<tr><th>Characteristic</th><th>Description</th></tr>
<tr><td>Length</td><td>The measurement from stem to tip</td></tr>
<tr><td>Curvature</td><td>The degree of curvature</td></tr>
<tr><td>Symmetry</td><td>The balance of shape on both sides</td></tr>
<tr><td>Tapering</td><td>The gradual narrowing toward the tip</td></tr>
<tr><td>Angularity</td><td>The presence of angles or bends</td></tr>
<tr><td>Cylindrical</td><td>Straight and cylindrical shape</td></tr>
<tr><td>Curved</td><td>Gentle curve along the length</td></tr>
</table></td></tr>
</table>

<table>
<tr><td></td><td>
<table>
<tr><td>Slightly curved</td><td>Slight curve with some straight portions</td></tr>
<tr><td>Straight</td><td>No significant curve or bend</td></tr>
<tr><td>Irregular</td><td>Non-uniform or unique shape</td></tr>
</table>
By observing and evaluating these characteristics, you can identify and describe the shape of different banana varieties.
</td></tr>
<tr><td>Skin</td><td>Estimating the color, thickness, and streaks of skin
<table>
<tr><th>Skin Characteristic</th><th>Description</th></tr>
<tr><td>Smooth</td><td>Even without noticeable texture</td></tr>
<tr><td>Textured</td><td>Rough or bumpy texture on the surface</td></tr>
<tr><td>Speckled</td><td>Small spots or speckles on the skin</td></tr>
<tr><td>Striped</td><td>Vertical or horizontal stripes on the skin</td></tr>
<tr><td>Thick</td><td>Relatively thicker skin compared to other bananas</td></tr>
<tr><td>Thin</td><td>Relatively thinner skin compared to other bananas</td></tr>
</table>
This table, can describe the skin characteristics and use the corresponding term to identify the skin type of the banana.
</td></tr>
<tr><td>Flesh</td><td>Recording the color, texture, and flavor of the RDB and measuring the flesh of a banana is also done through visual observation and texture assessment
<table>
<tr><th>Flesh Characteristic</th><th>Description</th></tr>
<tr><td>Firm</td><td>Dense and resistant to pressure</td></tr>
<tr><td>Soft</td><td>Yielding to slight pressure, but not mushy</td></tr>
<tr><td>Creamy</td><td>Smooth and creamy texture</td></tr>
<tr><td>Moist</td><td>Moist and juicy</td></tr>
<tr><td>Fibrous</td><td>Contains noticeable fibers</td></tr>
<tr><td>Tender</td><td>Easily breaks apart with minimal pressure</td></tr>
<tr><td>Starchy</td><td>Dense and more dry texture</td></tr>
<tr><td>Sweet</td><td>Pleasingly sweet taste</td></tr>
<tr><td>Tart</td><td>Slightly sour or acidic taste</td></tr>
</table>
This table, can describe the flesh characteristics and use the corresponding term to identify the texture and taste of the banana flesh.
</td></tr>
<tr><td>Taste</td><td>Estimating the taste of RDB, Measuring the taste of a banana can be subjective and influenced by individual preferences. However, you can use general descriptors to categorize the taste of bananas.
<table>
<tr><th>Taste Characteristic</th><th>Description</th></tr>
<tr><td>Sweet</td><td>Pleasantly sweet with natural sugar notes</td></tr>
<tr><td>Mild</td><td>Subtle and gentle taste</td></tr>
</table>
</td></tr>
</table>

	Tangy	Slightly tart or acidic taste
	Creamy	Smooth and rich flavor
	Tropical	Exotic and reminiscent of tropical fruits
	Balanced	Well-rounded taste with a good balance of flavors
	Bland	Lacking strong flavor or taste intensity
	Overripe	Overly sweet or mushy due to ripeness
	Subtle	Delicate and nuanced taste
	In this table, you can describe the taste characteristics and use the corresponding term to identify the taste perception of the banana. Remember that individual taste preferences may vary, so it's important to consider this when interpreting the results.	

2.3.Proximate analysis of Banana

The proximate composition of the processing banana verities (moisture, protein, fat, dietary fiber and ash, carbohydrate, and calorie, will be determined using standard methods by the Association of Analytical Chemists (AOAC, 2005).

Statistical Analysis

All experiments will be conducted in triplicate and data obtained will be analyzed with Statistical Package for Social Science (SPSS) version 20 software. Descriptive statistics: to determine the mean and standard error value of the nutrient composition of the food commodities. All values will be expressed as meant ± standard deviation for test and control groups. Analysis of variance (ANOVA) will be used to determine the variation existing within the values of the nutrient composition parameters of the feeds. Post hoc and Duncan multiple range tests will be used to determine the significant difference existing within the variations in nutrient composition parameters of the feed.

Chemical and nutrient composition such as TSS, acidity, total carbohydrates, proteins, and total minerals present in the ripe bananas will be estimated as per the methods.

Table. 2.2. Estimation of Chemical and Nutrient composition of RDB.

Chemical analysis Test	**Methods using test**	**Reference**
Total Soluble Solids	Refractometry	AOAC Official Method 932.12
Acidity	Titration (using a standardized base solution)	AOAC Official Method 942.15

Total Carbohydrates	Spectrophotometric methods (e.g., Anthrone method)	AOAC Official Method 996.11
Protein	Kjeldahl Method (Total Nitrogen determination)	AOAC Official Method 990.03
Total Ash	Gravimetric method (Incineration at high temperatures)	AOAC Official Method 942.05
Total Minerals	Atomic Absorption Spectrophotometry or ICP-OES	AOAC Official Method 985.01
Sodium	Flame Photometry or Atomic Absorption Spectrophotometry	AOAC Official Method 920.150 or 985.01
Potassium	Flame Photometry or Atomic Absorption Spectrophotometry	AOAC Official Method 920.150 or 985.01
Calcium	Atomic Absorption Spectrophotometry	AOAC Official Method 927.02

3. Phytochemical analysis, and Antioxidant properties of selected Banana variety

3.1.Preparation of the extract

The fresh and ripened fruits will be removed from dust particles and peeled off. They will be cut into small pieces, from which a 25g fruit sample will be taken and ground well with the help of mortar and pest-le and the extraction of banana will done using petroleum ether, methanol, and distilled water as solvents. Extracts will centrifuged at 5000rpm for 20 minutes. The supernatant extracts will kept overnight for incubation at room temperature.

3.2. Antioxidants And Antioxidant Activity

Table. 3.3. Estimation of Antioxidants and Antioxidant Activity

Antioxidants and Antioxidant Activity	**Method**	**Reference**
β-Carotene	Spectrophotometric assay or high-performance liquid chromatography (HPLC)	Rodriguez-Amaya, D.B. (2001). A Guide to Carotenoid Analysis in Foods.

Ascorbic Acid	Titration method (e.g., iodometric titration) or enzymatic assay Percentage inhibition= (Absorbance of control - Absorbance of the test)× 100 Absorbance of control	Food and Agriculture Organization of the United Nations (FAO) (1988). Food and Nutrition Paper No. 52

3.3.**Estimation of Phytochemical analysis**

Table. 3.1. Estimation of Phytochemical analysis

Phytochemical Analysis	**Method**	**Reference**
Total Alkaloids	Acid-base extraction and spectrophotometric determination	Harborne, J.B. (1998). Phytochemical Methods - A Guide to Modern Techniques.
Total Flavonoids	Colorimetric assay (e.g., Aluminum chloride method)	Zhishen, J., Mengcheng, T., & Jianming, W. (1999). Journal of Agricultural and Food Chemistry, 47(3), 1019-1024.
Saponins	Foam test or gravimetric method	Trease, G.E., & Evans, W.C. (2009). Pharmacognosy.
Total Phenols	Folin-Ciocalteu method or spectrophotometric assay	Singleton, V.L., & Rossi, J.A. (1965). American Journal of Enology and Viticulture, 16(3), 144-158.
Tannins	Colorimetric or spectrophotometric method	Makkar, H.P.S. (2000). Quantification of Tannins in Tree Foliage: A Laboratory Manual for the FAO/IAEA Coordinated Research Project on "Use of Nuclear and Related Techniques to Develop Simple Tannin Assays for Predicting and Improving the Safety and Efficiency of Feeding Ruminants on Tanniniferous Tree Foliage."

3.4. Analysis of data

All the analyses will be done in triplicates. To obtain a suitable interpretation the generated data will be subject to statistical analysis like One-way Analysis of Variance (ANOVA) at 0.05% significant level and the Kruskal Wallis test. Graphical interpretation of analyzed data will be also adopted.

4. To Process and Standardization of the selected banana variety of Musa Acuminata 'Red Dacca'(Red Banana)

4.1. Drying process of selected Banana varieties

The protocol for dehydration of **Red Dacca Banana** will be studied in terms of time and temperature of drying, pretreatments, and methods of drying.

4.1.1. Procurement and preparation of Red Dacca Banana

The raw material required for dehydration studies will be procured from the local market. The Red Dacca Banana will be sorted with healthy fruit. Selected Red Dacca Banana will be washed by dipping it in water for one minute. The procedure will be repeated till the fruit is devoid of dirt and soil. The sorted and cleaned Red Dacca Banana will be divided into four slots.

4.1.2. Pretreatments

Pretreatment methods for bananas, including blanching, Sulphiting, combined blanching and Sulphiting, and a control group without any pretreatment, are commonly employed in food processing to prepare bananas for various applications. Here's a brief overview of each pretreatment method:

4.1.2.1. **Blanching**:

- Blanching involves briefly immersing bananas in boiling water or steam.
- Purpose: Blanching helps inactivate enzymes present in the bananas, such as polyphenol oxidase and peroxidase, which can cause browning and degradation of colour, flavour, and nutrients.
- Method: Bananas are typically submerged in boiling water or exposed to steam for a short duration, usually ranging from a few seconds to a few minutes, depending on the specific requirements of the product and desired outcomes.

4.1.2.2. **Sulphiting**:

- Sulphiting refers to the treatment of bananas with sulfur dioxide (SO2) or sulfite solutions.
- Purpose: Sulphiting helps prevent enzymatic browning, microbial growth, and oxidation of phenolic compounds in bananas, thereby preserving their colour, flavour, and overall quality during processing and storage.
- Method: Bananas can be treated with sulfur dioxide gas or sulfite solutions by either spraying, dipping, or fumigating the fruit. The concentration and duration of sulphiting treatment may vary based on the specific application and regulatory requirements.

4.1.2.3.**Blanching and sculpting**:

- This pretreatment method involves the sequential application of both blanching and sulphiting techniques.
- Purpose: Combining blanching and sculpting enhances the effectiveness of enzyme inactivation and microbial control while preserving the quality attributes of bananas.
- Method: Bananas are first subjected to blanching followed by sculpting treatment. The sequence and duration of each treatment step can be adjusted based on the desired outcomes and processing requirements.

4.1.2.4. **Control (No Pretreatment):**

- The control group involves bananas that undergo no pretreatment and serve as a reference or baseline for comparison with pretreated samples.
- Purpose: The control group helps evaluate the impact of pretreatment methods on various quality parameters of bananas, such as colour, texture, flavour, and nutritional content.
- Method: Bananas in the control group are typically used directly without any pretreatment before further processing or analysis.

4.1.3. Dehydration of Red Dacca Banana

The pretreated Red Dacca Banana will be dried by four methods microwave oven, hot air oven, and sun drying. The time required for drying and the yield (%) obtained will be recorded.

4.1.3.1.**Microwave drying:** The pretreated Red Dacca Banana will be sliced and spread in a single layer in the microwave-safe tray and allowed to dry at 100 percent power (2250 Hz). Drying will continue till the Red Dacca Banana becomes crisp and the time taken for drying will be recorded.

4.1.3.2.**Hot air oven drying:** The pretreated Red Dacca Banana will be sliced and spread over the aluminum trays and dried at 60° C till the slice becomes brittle and is crushed easily when handled between fingers. Time taken for drying will be recorded.

4.1.3.3.**Sun drying:** Pretreated Red Dacca Banana will be sliced and spread on a cotton cloth in a tray for surface drying for one hour and then shifted to sunlight (38-42 C). Drying continued till the fruit slice became crisp. Care will be taken to avoid contamination by covering the tray with a thin muslin cloth. Time taken for drying will be recorded.

The dehydrated Red Dacca Banana will be grand a fine powder in a mixer grinder and packed in low-density polyethylene bags or air-tight containers or stored in air-tight aluminum containers for future use.

4.2.Edible Cutlery of Musa Acuminata Red Dacca Banana powder

4.2.1. Ingredients

Edible cutlery has been developed with all-natural ingredients i.e. basic ingredients like rice, sorghum, and millet. Additional ingredients like water, finger millet, Jaggery, oil, and salt. The Red Dacca Banana powder is incorporated in different proportions.

4.2.2. Procedure of Red Dacca Banana Edible Cutlery

4.2.2.1. Take different ingredients in different proportions with Red Dacca banana powder for a dough. Then kneaded well to form a fine dough

4.2.2.2. The dough is spread to make a fine sheet press the dough into sheets.

4.2.2.3. Press the sheets on the steel spoon and shape the dough sheet as a spoon shape.

4.2.2.4. Transfer it into baking oven at 300˚C - 360˚C 10-15 minutes /180ºC for 40-60mins/166 °C for 10-15 minutes

4.2.2.5. Bake and let it cool

4.2.2.6. Remove the edible cutleries from the steel spoon.

4.2.2.7. Then let it cool pack it in an airtight package and store it at a cool, dry place.

5. To Study the Storage and shelf life of selected Musa Acuminata 'Red Dacca' banana powder

In the project, the storage and shelf life of Musa Acuminata Red Dacca banana powder will be investigated. The banana powder will be stored in polyethene covers as packaging material. The storage study will be conducted using different temperature conditions, including refrigerator, deep freezer, and room temperature settings.

5.1.**Refrigerator Storage:**

- The banana powder samples will be stored in a refrigerator set at a specific temperature, typically around 4°C (39°F).
- Refrigerator storage is ideal for preserving the quality of perishable food products by slowing down chemical and microbial degradation processes.
- This storage condition will help assess the shelf life of the banana powder under controlled cool temperature conditions.

5.2.**Deep Freezer Storage:**

- Banana powder samples will also be stored in a deep freezer maintained at a constant low temperature, typically below -18°C (0°F).
- Deep freezing provides a longer-term storage option and helps to maintain the quality and nutritional value of food products for an extended period.
- This storage condition will enable researchers to evaluate the long-term stability and shelf life of the banana powder under frozen conditions.

5.3.**Room Temperature Storage:**

- Another set of banana powder samples will be stored at room temperature, typically around 20-25°C (68-77°F).
- Room temperature storage represents real-life conditions encountered during the storage and transportation of food products in non-refrigerated environments.
- This storage condition will help assess the stability and shelf life of the banana powder under ambient temperature conditions, which are commonly encountered in retail settings and households.

6. To study the sensory evaluation and consumer acceptance of developed products

6.1.the sensory evaluation of developed products: According to the Institute of Food Technologists (IFT), sensory evaluation is a scientific method used to evoke, measure, analyse and interpret those responses to products as perceived through the senses of sight, hearing, touch, smell and taste (Stone and Sidel 1993; IFT 2007)

6.1.1. Selection of Judges: Panels of some judges will be selected using the triangle test at the laboratory level comprising both students and staff from the Department of Food Processing and Nutrition. The best banana varieties will be identified based on the quality attributes assessed through sensory evaluation.

6.1.2. Preparation of Score card: The sensory attributes such as appearance, color, flavor, taste, and texture will be assessed by assigning scores. The scorecard used for the evaluation of the following quality attributes of bananas is given in Appendix I.

6.1.3. Appearance: The quality of fruits can be ascertained to a great extent by their appearance. Consumer's fruit selection criteria are mainly based on the external appearance, which is strongly influenced by color. Appearance of the banana varieties will be assessed using a scorecard.

6.1.4. Flavour: Odor, taste, and mouth feel are the three components of flavor. The flavor of the banana varieties will be assessed using a scorecard.

6.1.5. Texture: The texture or firmness of the pulp of banana is an important harvest quality attribute in the assessment of quality at harvest. It could be used as a maturity ripening index also. Texture analysis is important in the evaluation of fruit's susceptibility to physical or mechanical damage. The texture of the fruits will be assessed using a scorecard.

6.1.6. Taste: Food is valued mostly for its taste. A scorecard will be used to assess the taste of each banana sample. Taste is also an important feature for acceptability and will be measured using a scorecard.

Overall acceptability: Overall acceptability of the banana varieties will be measured using a five-point scorecard (Appendix I) and also by a hedonic rating on a nine-point scale suggested by Meilgaard (2006) where 9 represents "extremely like" and 1 "extremely dislike" (Appendix II).

6.2. To study the consumer acceptance of the developed products

The developed product will be done with the consumer acceptability test for commercialization of the products. Consumer Acceptance Testing is appropriate for product development, competitor evaluation, shelf-life testing, and for screening before large-scale market research testing. Analyses include Ranking, Paired Preference, Rating etc

Conclusion

This research project aims to investigate various aspects of banana varieties, with a specific focus on Musa Acuminata 'Red Dacca' bananas in the North Karnataka region. The methodology consists of several steps to achieve the objectives of the study.

First, the documentation of banana varieties in the North Karnataka region will be conducted. A questionnaire will be developed, covering topics such as local banana varieties, consumption patterns, availability, and knowledge of nutritional and medicinal properties. The questionnaire will be pretested to ensure its suitability, and primary data will be collected through personal interviews with farmers, vendors, grocery clerks, and consumers. Additionally, samples of fresh and mature banana varieties will be collected from local markets, specifically focusing on Musa Acuminata 'Red Dacca' bananas from farmers in the Gulbarga region.

Next, the proximate analysis of banana varieties will be performed. Standard methods recommended by the Association of Analytical Chemists (AOAC) will be used to determine the moisture, protein, fat, dietary fibre, ash, carbohydrate, and calorie content of the processed banana varieties. Statistical analysis will be conducted using SPSS software, including descriptive statistics and analysis of variance (ANOVA).

The study will also involve phytochemical analysis to determine the presence of alkaloids, flavonoids, saponins, phenols, tannins, and other compounds in the banana samples. Antioxidant activity will be assessed through the estimation of ß carotene and ascorbic acid content.

To investigate the medicinal properties of Musa Acuminata 'Red Dacca', the documentation of medicinal properties will be carried out through interviews with farmers, vendors, grocery clerks, and consumers. Additionally, review articles will be collected from reputable sources to gather relevant information on the medicinal properties of 'Red Dacca' bananas. Laboratory analysis will be conducted on the samples to analyze their medicinal properties.

Finally, the project aims to standardize the production of Musa Acuminata 'Red Dacca' banana dry powder. The dehydration process will be studied in terms of time, temperature, pretreatments, and drying methods. The samples will be subjected to blanching, sculpting, or a combination of both before being dehydrated using microwave drying, hot air oven drying, sun drying, or shade drying. The time required for drying and the yield obtained will be recorded.

The data collected throughout the study will be analyzed using statistical methods, including ANOVA and the Kruskal-Wallis test, to obtain suitable interpretations. Descriptive statistics and graphical interpretation will also be used to present the analyzed data.

Overall, this research project aims to provide valuable insights into the documentation, proximate analysis, medicinal properties, and standardization of Musa Acuminata 'Red Dacca' bananas in the North Karnataka region.

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